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Enhanced Effectiveness of Chlorination

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IT is well known that the antiseptic effectiveness of chlorine and of chlorinating compounds, such as hypochlorite and chloramines, is influenced by a number of factors. Among these factors are: concentration of chlorine, kind and amount of contamination, presence of certain types of organic and inorganic material, temperature, time of contact, pH.

This paper deals with certain of these factors and in particular with the effect of ammonium salts on chlorination.

Methods

1. Chlorine in solution was determined by the ortho-tolidine method, essentially as outlined in Standard Methods for the Examination of Water and Sewage, 9th edition. Permanent color standards were prepared in Nessler tubes for values of chlorine ranging from 0.01 to 1.00 p.p.m. For the free available chlorine test the ortho-tolidine reagent was allowed to react with the chlorine solution for 10 seconds rather than 5 seconds. This time extension permitted a much better evaluation, relatively speaking, of the chloramines derived either from ammonium ion or from organic material.

2. An agar Spot-Plate method was used for measuring bactericidal rate. The following are details of the method. Nutrient agar containing 2.5 grams of sodium thiosulfate per litre is poured in 10-ml. amounts into petri dishes and allowed to harden. Four 1-inch squares are marked off on the underside of each dish with a china marking pencil and each dish is given an identification marking. Using a standard 3-mm. platinum loop, one loopful of the bacterial-medication mixture is streaked on the designated square at the desired time interval.

With no change in bacterial population the squares show solid growth coverage, whereas with progressive killing at successive time intervals there is a corresponding decrease in colony density of the squares which may proceed to zero density.

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Paper received for publication January 24, 1952.

This last reading is taken to indicate 100% kill. When such plates are arranged in chronological order, a graphic picture of the qualitative and quantitative killing pattern of a bacterial-medication mixture is obtained.

The method may, by incorporating suitable neutralizers in the agar, be adapted to the testing of sterilizing agents other than chlorine and chloramines.

As compared with testing which may be carried out in fluid medium, the Spot-Plate method is less sensitive; this is particularly in evidence at the 100% kill end-point. This limitation of the method is not a drawback in comparative studies.

The Effect of Organic Material

In order to demonstrate the effect of organic material on chlorination, a simple experiment, which has been used as a class exercise, may be cited.

Two amounts of water are contaminated with equal concentrations of *E. coli*. With one water *E. coli* is added as a 24-hour broth culture in the proportion of 1 ml. per litre, with the other water the *E. coli* is added as a saline suspension of micro-organisms spun down from a 24-hour broth culture; that is, the concentration of *E. coli* is the same in the two waters but there is a difference in content of dissolved organic material.

Chlorine, as calcium hypochlorite, is now added in varying amounts to portions of the two contaminated waters, for example in amounts sufficient to give initial concentrations of 2, 3, and 5 p.p.m. of chlorine. The waters are let stand for 30 minutes and are then tested for viable bacteria by innoculation into suitable broth.

The results of this test show that the three waters contaminated with the saline suspension of micro-organisms are sterile whereas the three waters contaminated with the broth culture may still show contamination.

In this latter group, where contamination is still in evidence after 30 minutes' contact with chlorine, there may be as much as 1 p.p.m. of chlorine present as shown by the starch-iodide test or by the ortho-tolidine test. This observation is of some importance since it indicates that chlorination may sometimes fail even when "properly" carried out.

The Effect of Ammonium Salts on Chlorination

When either ammonia or an ammonium salt such as ammonium chloride is added to a solution of chlorine or of hypochlorite, chloramines are formed. Chloramines of substituted ammonia may also be prepared, as, for example, Chloramine T or Halazone. Different opinions have been recorded in the literature regarding the relative effectiveness of chloramines and chlorine or hypochlorite. The problem was of sufficient importance to warrant a re-investigation.

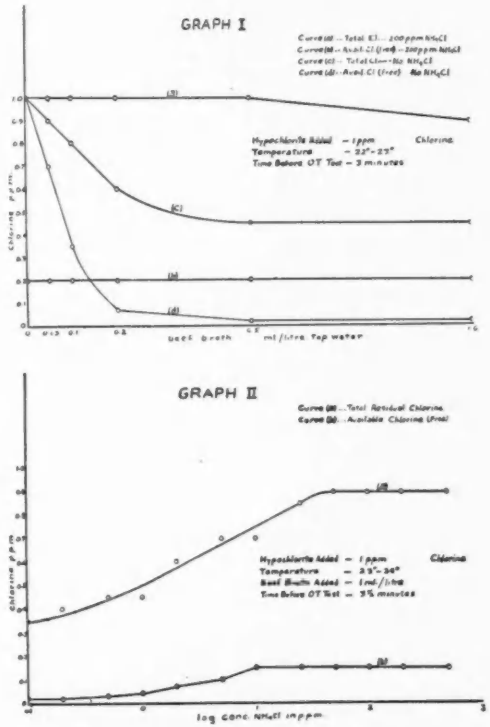
(a) *Chemical Tests*

Using the ortho-tolidine test, observations were carried out on the effect of ammonium chloride on available (free) and total chlorine in waters with and without added organic material. This latter was supplied by beef broth (extract of one pound of minced beef per litre plus 10 grams of Bactopeptone).

Graphs I and II summarize results where chlorine was supplied as hypochlorite.

In the absence of ammonium chloride, both available (free) and total chlorines fall to low levels with increasing amounts of beef broth, whereas in the presence of 200 p.p.m. of ammonium chloride both chlorines tend to maintain constant levels over the whole range of added beef broth. In the very low range of added beef infusion, available chlorine (free) is higher in waters not containing ammonium chloride.

This latter observation would suggest that for waters low in organic material, hypochlorite alone is more effective as a sterilizing agent than hypo-


GRAPH I
Hypochlorite Added – 1 ppm Chlorine
Temperature – 22°-25°
Time Before OT Test – 3 minutes
Chlorine p.p.m.
beef broth ml/litre Tap water
GRAPH II
Hypochlorite Added – 1 ppm Chlorine
Temperature – 23°-24°
Beef Broth Added – 1 ml/litre
Time Before OT Test – 3½ minutes
log conc. NH4Cl in p.p.m.

chlorite plus ammonium chloride, whereas in waters high in organic material the reverse is true. This suggestion was verified by subsequent bacteriological tests.

In Graph II there is shown the effect of increasing amounts of ammonium chloride on available (free) and total chlorine, in waters containing a constant amount of organic material. It will be noted that the amount of added ammonium chloride which gives maximum available (free) and total chlorine is well beyond that which represents stoichiometric proportions for the formation of chloramine.

Halazone and Chloramine T differ radically from hypochlorite as chlorinating agents. This difference is brought out in part in the results shown in Tables I and II.

Both Halazone and Chloramine T were added to Toronto tap water to give 0.5 p.p.m. chlorine.

For Halazone the available (free) chlorine and total chlorine in the solution containing no ammonium chloride were at first one-half the total chlorine that was added. These values fell off fairly rapidly with time. This chlorine which reacts immediately is analogous to hypochlorite chlorine and might be considered as deriving from one atom in the Halazone molecule. The remaining chlorine in the molecule reacts so slowly to the ortho-tolidine test that its influence is not observed in the 5-minute test period.

TABLE I

EFFECT OF AMMONIUM CHLORIDE ON HALAZONE

0.5 p.p.m. chlorine added

Time Min.	1000 p.p.m. NH_4Cl Total Chlorine p.p.m.	1000 p.p.m. NH_4Cl Available Chlorine (free) p.p.m.	No NH_4Cl Total Chlorine p.p.m.	No NH_4Cl Available Chlorine (free) p.p.m.
10	0.30	0.05	0.25	0.25
20	0.35	0.07	0.25	0.20
45	0.40	0.07+	—	—
90	0.50	0.10+	0.15	0.10
1500	0.50+	0.15	0.05	0.01

On the other hand, in the presence of excess ammonium salt the reaction of Halazone might be interpreted as follows: The hypochlorite chlorine atom reacts immediately with the ammonium chloride to form simple chloramine giving a total chlorine of 0.25 p.p.m. and available chlorine (free) of 0.05 p.p.m.; then the remaining chlorine atom reacts much more slowly with the ammonium ion to give the final complete transfer of the total chlorine added to simple chloramine in about 90 minutes.

A similar test using Chloramine T 0.5 p.p.m. added chlorine was carried out. Table II shows how this disinfectant behaves in the presence and absence of ammonium chloride.

TABLE II

EFFECT OF AMMONIUM CHLORIDE ON CHLORAMINE T

0.5 p.p.m. chlorine added

Time Min.	1000 p.p.m. NH_4Cl Total Chlorine p.p.m.	1000 p.p.m. NH_4Cl Available Chlorine (free) p.p.m.	No NH_4Cl Total Chlorine p.p.m.	No NH_4Cl Available Chlorine (free) p.p.m.
10	0.20	0.02	0.15	0.01
25	0.25	0.02+	0.15	0.01
90	0.35	0.07	0.15	0.01
120	0.45	0.10	0.15	0.01
150	0.50	0.10+	0.15	0.01
300	0.50+	0.10+	0.15	0.01

The chlorine atom attached to the Chloramine T molecule is shown to react so slowly with the ammonium ion that complete transfer is effected only after several hours. Undoubtedly the exact rate of reaction of these chlorine compounds with ammonium ion is influenced by such factors as temperature, pH, and the various concentrations of the reactants and foreign substances.

Bacteriological tests were carried out to substantiate the enhancing effects of ammonium salt as indicated by the ortho-tolidine test.

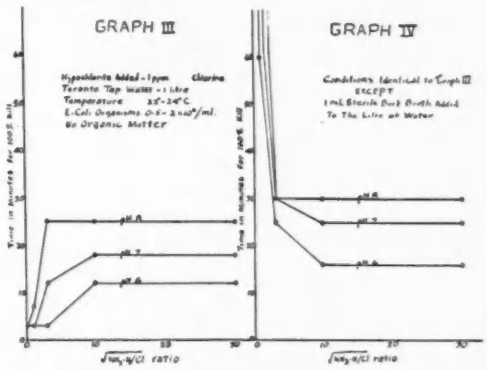
(b) *Bacteriological Tests*

1. *Effect of pH and Organic Matter on Ammonium Chloride—Chlorine Systems*

Degree of contamination was determined by the agar Spot-Plate technique. Washed *E. coli* organisms from 24-hour broth cultures were pooled and suspended in sterile isotonic saline prior to use. Sodium dibasic phosphate and sodium monobasic phosphate were used to buffer Toronto tap water to the desired pH. Beef broth was the same as that used under Chemical Tests.

Determinations sufficient to complete one curve were done simultaneously. One litre of buffered tap water was placed in a 3-litre flask; organic matter and ammonium chloride, when used, were added first; then 2 ml. of the stock *E. coli* suspension sufficient to give an *E. coli* density of $0.5—2\times10^6$ organisms per ml., were added and the mixture was "spotted" as a zero time check. Stock chlorine solution was added last to each flask at ½ minute intervals and the resulting bacterial-medication mixtures were "spotted" at 3, 7, 12, 18, 25, 30, and 60 minutes.

The results of tests with hypochlorite and Halazone as sources of chlorine are plotted on Graphs III, IV, V, and VI. For convenience in preparing these graphs, concentrations of ammonium chloride were expressed as the square root of the ratio of the reacting weight of ammonia-nitrogen to chlorine. Since 3 minutes was the first time-interval "spotted", cultures shown completely killed in 3 minutes were probably killed in half a minute or less.



These results show the marked inhibiting effect of organic material on hypochlorite and Halazone sterilization in the absence of ammonium salt. Subsequent tests have shown that in the presence of 0.1 ml. of broth per litre, and 1 p.p.m. chlorine as calcium hypochlorite, a 100% kill was observed in about 3 minutes, whereas with 0.3 ml. of broth per litre, complete kill was not effected in 1 hour. Tests with Halazone solution containing 1 p.p.m. chlorine and no organic material showed a complete kill within 3 minutes, whereas in the presence of 0.1 ml. broth per litre only a partial kill was effected in 1 hour.

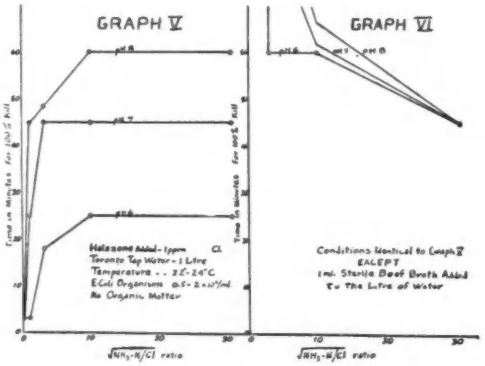
It is also clear that in water containing no organic material, ammonium

chloride slows up somewhat the rate of sterilization of both hypochlorite and Halazone, whereas in water containing organic material the rate of sterilization is increased up to a maximum by the addition of ammonium chloride.

The well-known effect of pH on chlorination may also be noted; namely the more acid the water, the more rapid is the sterilization.

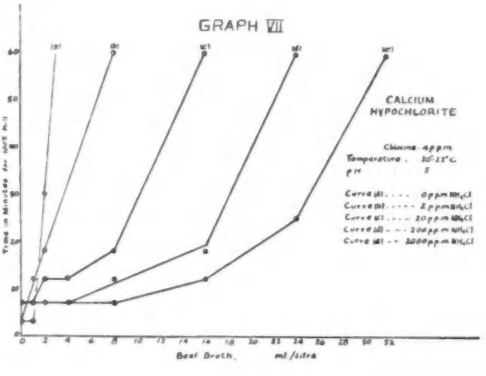
It is worthy of note, as shown in Graph VI, that for a water containing organic material the most rapid sterilization with Halazone is obtained in the water which contains the largest amount of added ammonium chloride, in this case 750 p.p.m. ammonium chloride. That is, the effectiveness of the chloramine, Halazone, has been markedly enhanced by the addition of a relatively large amount of ammonium chloride.

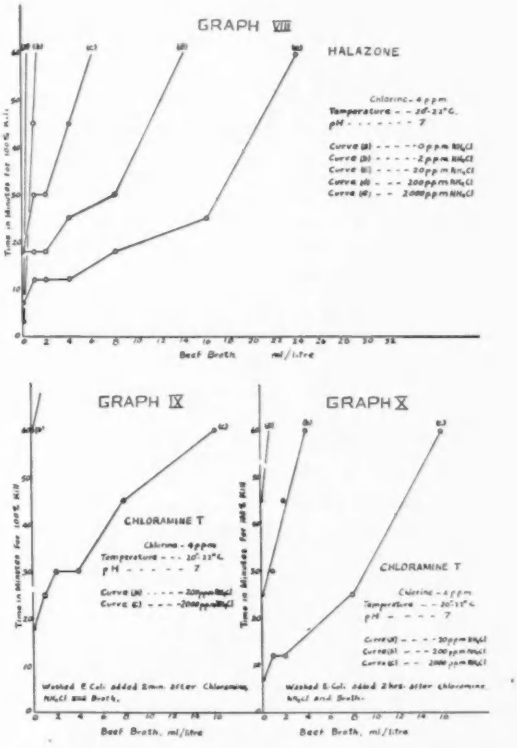
No curves are shown for Chloramine T that might be compared with those in Graphs III, IV, V, and VI, since under comparable conditions Chloramine T is relatively ineffective.



2. *Effect of Variations in Concentrations of Organic Matter on Ammonium Chloride—Chlorine Systems*

Calcium hypochlorite, Halazone or Chloramine T were used as sources of chlorine. Ammonium chloride and broth were added as indicated on the graphs. In all cases a washed culture of *E. coli* was added last.


GRAPH VII
CALCIUM HYPOCHLORITE
Chlorine 4 ppm
Temperature 20°-23°C.
pH 8
Curve (a) - - - - 0 ppm NH₄Cl
Curve (b) - - - - 2 ppm NH₄Cl
Curve (c) - - - - 10 ppm NH₄Cl
Curve (d) - - - - 100 ppm NH₄Cl
Curve (e) - - - - 1000 ppm NH₄Cl
Time in Minutes for 100% Kill
Beef Broth, ml/Litre


GRAPH VII
HALAZONE
Chlorine - 4 p.p.m.
Temperature - - 20°-22°C.
pH - - - - - - 7
Curve (a) - - - - 0 p.p.m NH4Cl
Curve (b) - - - - 2 p.p.m NH4Cl
Curve (c) - - - - 20 p.p.m NH4Cl
Curve (d) - - - 200 p.p.m NH4Cl
Curve (e) - - 2000 p.p.m NH4Cl
Time in Minutes for 100% Kill
Beef Broth, ml/litre
GRAPH IX
CHLORAMINE T
Chlorine - 4 p.p.m.
Temperature - - - 20°-22°C.
pH - - - - - 7
Curve (a) - - - - 200 p.p.m NH4Cl
Curve (c) - - - - 2000 p.p.m NH4Cl
Washed E. Coli added 2 min. after Chloramine, NH4Cl and Broth.
Time in Minutes for 100% Kill
Beef Broth, ml/litre
GRAPH X
CHLORAMINE T
Chlorine - 4 p.p.m.
Temperature - - 20°-22°C.
pH - - - - 7
Curve (a) - - - - 20 p.p.m NH4Cl
Curve (b) - - - 200 p.p.m NH4Cl
Curve (c) - - - 2000 p.p.m NH4Cl
Washed E. Coli added 2 hrs. after chloramine, NH4Cl and Broth.
Time in Minutes for 100% Kill
Beef Broth, ml/litre

Results recorded in Graphs VII, VIII, IX, and X demonstrate effectively:

1. That in the presence of appreciable amounts of organic material a large excess of ammonium salt markedly enhances the bactericidal effectiveness of hypochlorite or Halazone or Chloramine T.

2. That by increasing the concentration of ammonium ion it is possible to increase the amount of organic material without overpowering the bactericidal activity of the system.

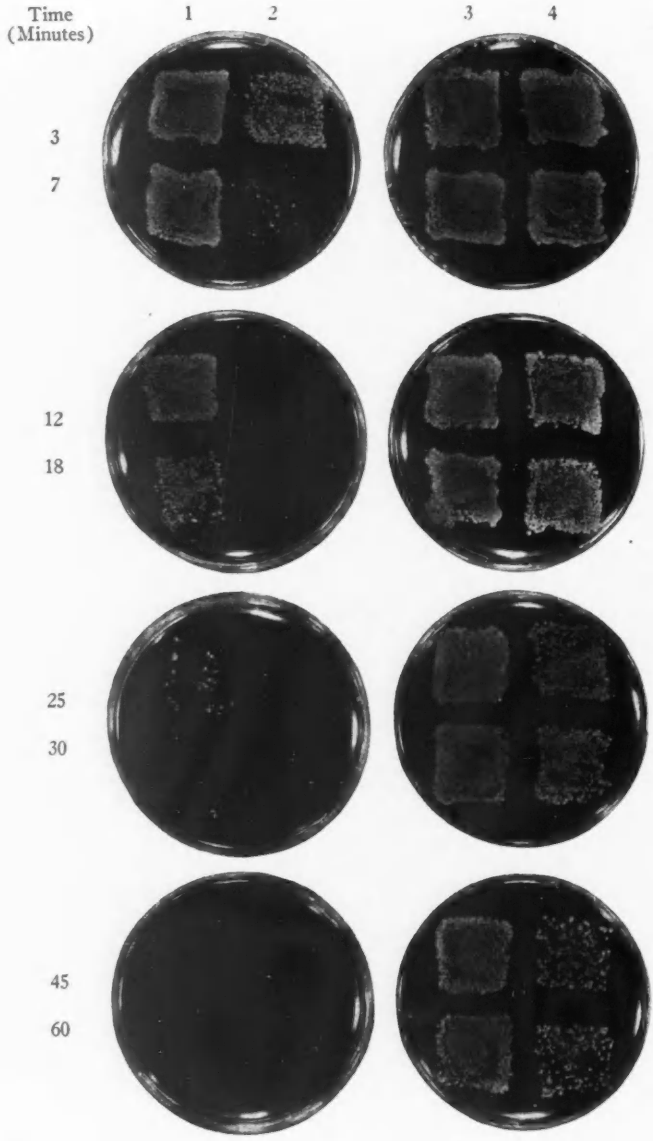
For Chloramine T, Graphs IX and X demonstrate bacterially what was suggested by results given in Table II; namely, that ammonium salt exercises a definite enhancing of bactericidal activity. Such enhanced activity is even more pronounced (1) when Chloramine T and ammonium salt are let stand for 4 hours rather than 2 hours and (2) when organic material is added after the period of standing.

The action of ammonium chloride in bringing out or unmasking the bactericidal effectiveness of Chloramine T is also shown in the accompanying photograph. In addition, the photograph shows again the marked enhancing effect of ammonium chloride on the sterilizing activity of Chloramine T in the presence of organic material.

Halazone behaves essentially as a combination of hypochlorite and Chloramine T, since one of the chlorine atoms in the molecule is immediately stabilized

while the other is slowly activated by ammonium ion. The activation of Halazone proceeds at a faster rate than that of Chloramine T.

Curves similar to those shown in Graphs VII, VIII, IX, and X were also prepared for the same chlorine compounds at added chlorine levels of two and one p.p.m. Similar bactericidal patterns, though at a lower intensity, were exhibited in all cases. It was interesting to observe that the curve for Halazone



Effect of Ammonium Chloride on Sterilization with Chloramine T

Water contaminated with a 24-hour broth culture of *E. coli*, 1 ml. per litre.
Temperature 23°C.
pH 7.2 ± 0.1

1. Ammonium Chloride 1000 p.p.m. and 2 p.p.m. chlorine added to contaminated water.

2. Ammonium chloride 1000 p.p.m. and 2 p.p.m. chlorine added to uncontaminated water and let stand for 5 hours, then *E. coli* added.

3. 4 p.p.m. chlorine added to contaminated water; no ammonium chloride.

4. 8 p.p.m. chlorine added to contaminated water; no ammonium chloride.

(4 p.p.m. added chlorine) was almost identical to that for hypochlorite (2 p.p.m. added chlorine). Since no waiting period was involved before the test, such a result would seem reasonable in the light of the two types of bactericidal chlorine contained in Halazone.

Summary

In the presence of organic material, as for example the organic material in beef infusion broth or in soapy dish water, the bactericidal activity of hypochlorite or Halazone or Chloramine T is markedly enhanced by suitable concentrations of ammonium ion. The concentration of ammonium ion which gives maximum effect depends, under given conditions, on the type and concentration of organic material. It is not probable that this enhancing effect is due solely to the formation of simple chloramines resulting from the interaction of chlorine and ammonium ion, since under certain organic loads the amount of ammonium ion required may be, stoichiometrically, several hundred-fold that of the added chlorine.

It would appear, then, that ammonium ion can exercise a "buffer" action in the sense that it tends to prevent chlorine from being inactivated by organic material and thus leaves the chlorine in the form of simple chloramines, free to act as an antiseptic. Ammonium ion for this purpose may be supplied by such salts as ammonium chloride, ammonium sulphate, ammonium nitrate, ammonium phosphate.

In order to distinguish between the application of relatively small amounts of ammonia or ammonium ion which are sometimes used with chlorine in water treatment and the relatively large amounts of ammonium ion which may be required to enhance the bactericidal activity of chlorine in presence of organic material, we suggest for this latter application the term "superammonation".

Ammonium ion reacts with chlorine and with chlorine compounds, such for example as hypochlorite, Chloramine T and Halazone, to form simple chloramines. With hypochlorite the rate of reaction is rapid, with Chloramine T the rate of reaction is slow, with Halazone the rate of reaction is rapid with half the chlorine of the molecule and slow with the remaining half. The slow formation of simple chloramines, due to the interaction of ammonium ion and Chloramine T or of ammonium ion and Halazone, manifests itself in the striking phenomenon of a slow increase or unmasking of the bactericidal activity of these compounds.

The work presented here suggests applications in certain fields of sanitation, as for example in the cleaning and sterilizing of food utensils and of dairy equipment, in certain aspects of water and sewage treatment, in laundrying. Where cleaning and sterilizing are required, it is possible because of the stabilizing action of ammonium salt on chlorine, to incorporate ammonium salt, chlorine compound and detergent in a single mixture.

It is purposed to continue the exploration of problems both practical and theoretical which have been suggested by the work reported here.

Public Health Across the Border

W. PALMER DEARING, M.D.
Deputy Surgeon General, Public Health Service
Federal Security Agency
Washington, D.C., U.S.A.

YOU can surely sense my personal pleasure in addressing this annual assembly of the Canadian Public Health Association meeting jointly with the new Manitoba Public Health Association. Doctor Elliott's cordial invitation to participate in your meeting not only honours the Public Health Service, but also affirms the close relationships of all health workers in Canada and the United States.

Canadians and Americans have been drawn together and have ventured together in countless activities. Certainly in the development of our public health services Canada and the United States have moved toward common goals and along similar roads. And we can take deep satisfaction in the fact that, as we have moved closer to our objectives of better health for all our citizens, public health workers have maintained a continuous interchange of information and experience. In the councils and scientific meetings of the American Public Health Association, the Association of State and Provincial Health Authorities, and other professional bodies we work in double harness from long custom.

This collaboration has resulted in many joint projects between Canadian and American agencies which are familiar to all of us. The International Joint Commission on the pollution of boundary waters, the joint study of air pollution problems over the international boundaries in the Windsor-Detroit area, and the cooperative arrangements to assure safe water, food, and milk supplies on international trains, airplanes, and ships, are familiar examples.

In recent times, civil defense has brought Canada and the United States together in an extensive cooperative undertaking. There has been close collaboration between our two countries in this field for many years, and Congress formally provided for international agreements when it passed our present Civil Defense Act in January 1951. The working group on Medical, Health, Special Weapons Defense and Emergency Welfare Services is among the more active undertakings. Some of the important objectives are exchanging information, standardization of stock-piles of medical supplies and equipment, and development of uniform casualty records. One of our Civil Defense officials has recently commented that working relations with Canada are much closer than among some of our own States.

Both countries have followed the sound principle of decentralization to Provinces and States of responsibility for health services and their administration, while the national governments assist with consultation and financial support.

Presented at the fortieth annual meeting of the Canadian Public Health Association, held in the Fort Garry Hotel, Winnipeg, June 16–18, 1952, in conjunction with the first meeting of the Manitoba Public Health Association.

Neither country has yet fully solved the problem of assuring well-organized comprehensive health services in all parts of our lands. Advancement of technology furthermore has brought demands for the health expert to extend his interest and activities to new fields, both physical and social. Housing, accident prevention, air pollution, care of the chronically ill and the aged, physical rehabilitation, and employment of handicapped are examples.

Canada is a recognized world leader in health statistics, and the United States has been proud to collaborate in that field. The Canadian morbidity study will be an important source of data on the amount and prevalence of illness and on Canada's health needs. Like the National Health Survey, conducted by the Public Health Service in 1935 and 1936, it will give a basis for analysis of health problems on a nation-wide scale. But the job is a continuing one. Considerable work is being done in the United States to improve the techniques of morbidity surveys, in recognition of the importance of obtaining periodic data on illness and disability. The problem is not solved completely by one-time projects.

As our job grows, we need better methods of administration and evaluation of our performance. We have bent substantial efforts in recent years in the United States toward administrative research and planning. Let us examine more closely some of the trends which challenge our knowledge and our resourcefulness.

Expanding Scope of Public Health Responsibilities

In 1916, Doctor Chapin,[1] in a report on State health organization, listed seven activities as encompassing the entire field of health service. A recent revision of the Public Health Service report on health services in the structure of State government[2] classified 36 activities under headings of general services, personal health services, and environmental health and safety services. A comprehensive report on the work of health departments of States and Provinces of the United States and Canada was originally prepared in 1929 by the International Health Division of the Rockefeller Foundation, at the request of the Conference of State and Provincial Health Authorities of North America. Successive editions of this summary noted cause for gratification in the gradual coast-to-coast extension of work in vital statistics, in communicable disease control, in quarantine measures, in laboratory services, and in sanitary engineering.

In the last decade, however, many of the important activities of those earlier years we now take for granted. Not that we have attained perfection in communicable disease control, vital statistics, or control of the environment, but we at least consider it our job. Public health programs are giving attention to services for the control of long-term diseases and conditions prevalent among the aged. Our growing appreciation of the relationships between chronic illness and social and economic conditions has led to increasing emphasis on methods of preventing chronic disability through early case-finding, prompt treatment and rehabilitation, and a broadened appreciation of problems of our environment. This new slant approaches problems of housing hygiene, home accident prevention, control of air and stream pollution, and even reduction of dental caries. Thus any realistic definition of public health today would recognize that almost everything going on in a community—at home, at work, at play—affects to some degree the health of that community.

With our increasing knowledge of the causes of illness and our expanding body of information about methods of prevention, treatment, and rehabilitation, persons engaged in health activities have become increasingly aware of the wide gap between scientific progress and the translation of that knowledge into services to individuals. Problems of manpower and facilities, their distribution, organization, and utilization arise. We face problems of measuring needs for health services. We must be concerned also with methods of financing health services to assure the maximum and optimum use of our manpower, facilities, and knowledge. These problems can be solved only through research—not only into the technical but also into the social, economic, and financial aspects of medical services; research in community and regional organization of resources; research in methods of investing the health dollar where it will yield the highest dividends in the quality of service and in the health of present and future generations.

A guidepost for effective planning in this type of research was set by the Pittsburgh Conference on Methods in Public Health Research in May 1950.[3] That conference pooled the experience of health administrators, economists, social scientists, and biostatisticians on survey methods in the health field. Research of this type needs the same sort of clear formulation of objectives, standardization of measurements, and careful controls as are required in laboratory research in the physicial and biological sciences. It represents a relatively new field of fact-finding and verification of observations and deductions as to the health status of individuals and their families and communities. Research of this type will help us meet health needs and improve health resources and health practices as clearly as test-tube research and work with experimental animals helps us to match immunizing agents and antibodies against bacterial and virus infections.

Such studies are difficult and expensive because they deal with human beings and how they behave, and the infinite variability makes precise measurement extremely difficult. Only by the discipline of continuous self-appraisal, therefore, can we overcome the barrier of ineffective methods of organization and administration through which to apply new knowledge and techniques.

Examples of Recent Public Health Research in the United States

Research methods and findings as to health resources, health practices, and health needs in the United States are relevant to many of the questions you face in Canada. Brief mention of our studies of education for the health professions, of utilization and organization of personnel and resources, of indices of the quality of health services and of measures of the health needs of the population will illustrate the extent to which concern in the United States centres on review and appraisal of our effectiveness in producing and utilizing our health resources.

Education of Health Personnel

A comprehensive study of medical schools—their curriculums, faculty, objectives, standards, and achievements—is being conducted by a joint committee of the Association of American Medical Colleges and the Council on Medical Education and Hospitals of the American Medical Association. This study is the first attempt at thorough-going appraisal of medical education in the U.S. since

the important Flexner report of 1910,[4] and it complements a study of medical school grants and finances, made under the direction of a committee of educators appointed by the Public Health Service on recommendation of the National Advisory Health Council.[5] Our study investigated the basic operating costs of our medical schools, the costs of separately organized research, the income sources of the schools, and the impact of Federal Public Health Service research and training grants on the financial structure and faculty resources for medical education. (Also, the opinions of the deans of the schools were obtained as to the needs of their schools for additional funds to improve or even maintain quality of instruction for their present enrollments and for the increased enrollments that many schools were contemplating.)

The report of a similar study of dental schools will soon be off the press.[6] That study was made by the Public Health Service at the request of the American Dental Association, with the advisory services of a committee appointed by the Council on Dental Education of that Association. The report will give a national picture of the financial needs and resources of dental schools, in terms of faculty, operating expenses, income sources and amounts, and expenses for separately budgeted research.

Both these financial studies tell a similar story: Mounting costs for professional education; mounting tuition fees that nevertheless yield decreasing proportions of expenses for faculty salaries, equipment for instruction, plant operation and maintenance, administration, and libraries; shortages of faculty, space, and equipment; mounting reliance on public appropriations and general university funds to finance the education of medical and dental students. Realistic acceptance of these financial facts is a necessary preliminary to formulation of sound policies for maintaining our future supply of well-trained physicians and dentists and for maintaining high standards of professional education.

The Association of Schools of Public Health has requested a comprehensive survey of schools of public health. The Public Health Service has completed field work for that study, and analysis of the data is in process.

A recently issued report of a Committee on Improvement of Nursing Services[7] —a committee of the Joint Board of six national nursing organizations—points out the deficiencies in organization, facilities, and support for nursing education.

Utilization of Health Personnel

A first essential in appraising efficiency of health services is a determination of the effectiveness with which personnel and financial resources are used. Management studies of the functions and responsibilities of specially trained personnel frequently identify activities that can be performed by persons with lesser skill and shorter, less expensive training. These management analyses and techniques need wider application in the field of health services as demands on our limited current and prospective corps of physicians, dentists, nurses, public health administrators, and sanitary engineers increase.

Among the health professions, nursing is undoubtedly the most active in research on organization, administration, and evaluation of standards of practice. Nurses of the Public Health Service have collaborated with the various nursing organizations in the planning and conduct of many of the studies done in the

United States in the past decade. A recent article by Petry, Arnstein, and McIver[8] reviews the scope and trends of nursing research.

Analyses of nursing functions are being developed on a broad scale through the Technical Committee on Research of the American Nurses' Association. The A.N.A. program is the first attempt to focus national attention on research of this type. In this one major effort, current practices of professional nurses, practical nurses, and auxiliary personnel will be studied in a representative sample of hospitals to determine the most efficient distribution of functions among all types of nursing personnel in hospitals.

An example of this type of research is a study[9] of head nurse functions, conducted by the Public Health Service at the request of the Massachusetts General Hospital. The objective was to find the ways in which the head nurse could perform more efficiently, through the better allocation of duties.

Study revealed in this hospital that head nurses were spending the bulk of their time on activities traditionally considered proper for a head nurse—activities directly concerned with the provision of nursing service to patients and with ward management. Critical appraisal revealed, however, that 50 per cent of the time spent in ward management was reassignable to a clerk. This would give the head nurse more time for her essential responsibilities of supervising patient care, and of orientation, on-the-job training, and guidance of the nursing personnel.

Since this study was published in 1951, some 150 hospitals have sent representatives to teaching institutes to learn how they may examine and evaluate the activities of their head nurses. As these studies progress, the impact on hospital and nursing administration in terms of better use of professional personnel should not only improve patient care but also reduce costs and conserve and spread further our short supply of trained personnel.

Similar studies of the techniques of dental practice analyze the functions of a dentist to determine the responsibilities he can delegate to a dental hygienist or dental assistant, thus reserving his own professional skills for services that he alone can perform. A Public Health Service questionnaire survey of 1,400 dentists[10] indicates that the number of patients a dentist is able to serve can be increased from 33 to 75 per cent through the use of trained assistants. Moen and Fitzgerald[11] found that dentists who employed one assistant averaged 37 per cent more patients than those working without such employees, while dentists with two assistants averaged 69 per cent more patients.[12]

Group medical practice is an illustration of sound efforts to pool the resources and skills of several physicians and to share equipment, overhead costs, and the expenses and services of nurses, technicians, and accountants. Observations on the advantages of such organization of practice from the standpoint of the participating physicians were obtained by the Public Health Service in a comprehensive survey of 368 medical groups in the United States.[13] This study has gathered data on types of organization and administration, income, volume of work, kinds and effectiveness of service rendered, relationships with hospitals, varieties of specialists, remuneration of physicians, and fees. It has also provided data on the relation between types of care given to patients and the training of physicians in the group.

Significantly, group practice is a popular form of organization for comprehensive medical care plans such as the Health Insurance Plan of Greater New York. The growing experience of these plans is providing important new information on the quality of medical care and the amount and costs of services required by various population groups.

Appraisal of Quality of Health Services, Environmental Factors, and Medical Care

Local Health Services

Self-examination and appraisal of organization and operation have long been tools in the public health field. The American Public Health Association's Committee on Administrative Practice and its Subcommittee on Medical Care in which you are members have studied the functions of local health departments over a period of years. Continuous follow-up has led to a revision in 1950 of the "basic six" formula enunciated in 1940 as the minimum function of the local health unit.

In its revision, the A.P.H.A.[14] noted that due to rapid developments in the health sciences and in the provision of services, "definitions of local health services and responsibilities based on limited categories of activity have become quickly outmoded." It noted further that it is essential to define the "optimal"—rather than the minimal—responsibilities of local health departments.

Dr. Joseph W. Mountin, whose recent tragic death has been a blow not only to us in the U.S. but to the world fraternity of health workers, interpreted the significance of this study in organization and administration. He said:

"The transition from a concept of 'basic' services to one of 'optimal' services is an extremely important one. It raises our sights far above the routine and static activities that still characterize too many health departments. It means a recognition of the realities of the day. And it implies the readiness, the willingness, and the competence to step in and take some positive action wherever a health problem exists and is being neglected."[15]

Various committees of the American Public Health Association have conducted significant studies in their special fields. A pioneer task has been accomplished by the Committee on the Hygiene of Housing under the chairmanship of Professor C.-E. A. Winslow. Over a period of years, the Committee, with a staff of widely varied technical backgrounds, developed the tools and techniques for appraising the quality of housing, as it affects health in the broadest sense.[16]

The Public Health Service has cooperated with the Committee, both in the conduct of the studies and in stimulating the use of the appraisal method in many cities. Health agencies, as well as housing officials and planners, are finding the technique remarkably accurate for evaluating the quality of urban housing.

With the expanding interest of health officials in the housing problem has come a need for more effective administrative-legal measures to control the hygienic quality of existing housing. The Public Health Service has been collaborating with the Massachusetts State Department of Public Health and the Housing Association of Metropolitan Boston to study and develop effective procedures which health officials may follow in enforcing housing and sanitary codes.

Quality of Medical Care

Indices of quality of care have been much less developed than those of quantity of care. One significant step toward measurement of quality has been made in studies of clinic records of the medical groups under contract with the Health Insurance Plan of Greater New York. The factors analyzed included the adequacy of records; the completeness of history, physical examination, diagnosis, therapy, and follow-up; and the extent to which preventive medicine is practiced.[17]

The Committee on the Costs of Medical Care, in 1932, analyzed the volume and types of medical care required for specific diseases and handicapping conditions against estimate of prevalence and incidence rates for those conditions.[18] Since then little attempt has been made to measure needs for medical services against the background of what would currently be considered adequate medical care.[19]

A beginning is to be made now in projected surveys in Baltimore and in Hunterdon County, N.J.[20] These studies will determine for an urban and a rural area the extent of chronic disease in the population by house-to-house canvass supplemented by physical examinations of a part of the sample. The novel feature of the studies will be an appraisal of the needs for medical and related services of individuals found in the house-to-house survey to have chronic diseases. These studies will help to make it possible for a community to use its morbidity statistics in determining its needs for health personnel and facilities.

Regional Planning

Another aspect of efforts to improve the quality of health services, particularly outside well-equipped urban medical centres, is the impetus given toward regional organization of hospitals by our National Hospital Survey and Construction Act. There are developing an increasing number of regional plans for extending the influence of medical schools and teaching hospitals to wide medical service areas.

Tulane University in New Orleans has developed a demonstration project to determine the usefulness of consultation and other medical centre services to rural physicians.[21] Many of these physicians are older men with overloaded practices in communities that lack modern diagnostic and therapeutic facilities.

The Bingham Associates plan in New England, the Rochester plan in New York, and other regional plans in Colorado, Michigan, Minnesota, North Carolina, and Virginia give evidence of an increasing attention to region-wide distribution of medical resources. Lembscke's recent article summarizes the purposes, structure, and potentialities of these plans in improving the quality of medical care.[22]

Evidences of Public Concern with the Socio-economic Problems of Health

The article I have just cited appeared in a special issue of the Annals of the American Academy of Political and Social Sciences devoted entirely to the topic of Medical Care for Americans. Significant leaven is indeed at work when medical services are a major interest of political and social scientists and not alone

of health service administrators and private practitioners. Medical care plans and proposals make headlines on both sides of our border in this era of critical appraisal of our health needs and resources.

Evidences of widespread public concern with these problems in the United States are doubtless already familiar to you. I shall therefore merely list some of the recent studies and reports and commissions that give intensive scrutiny to the economic, social, and medical aspects of health.

The Health Resources Advisory Committee of the Office of Defense Mobilization under the chairmanship of Dr. Howard A. Rusk, was appointed personally by the President. It has responsibility for overall planning for the allocation of health manpower as between civilian and military requirements with particular reference to the defense mobilization program. It is making continuing studies of needs, resources, and training potential in the health professions. It has also been made responsible for the development of a national blood program looking toward the solution of the problem of collection and allocation of blood and blood derivatives.

The Commission on Chronic Illness, as you know, has held a conference on preventive aspects to pool expert knowledge of screening methods, diagnostic procedures, and potentialities for preventing the primary and secondary consequences of chronic illness.[23]

The U.S. Senate two years ago set up a special study group, under the direction of Dr. Dean Clark, which has summarized existing data on voluntary insurance in the United States and certain aspects of government activities in the field of health services.[24]

The Commission on Financing Hospital Care, established by the American Hospital Association and the American Medical Association, has launched a 2-year study. It will evaluate the current financial position of hospitals, study the need and demand for hospital services, analyze the effect of medical practice and advancing technology on hospital costs, evaluate systems of payment for hospital care, and investigate methods for most effective utilization of hospital resources.[25]

The Brookings Institute is completing a comprehensive study of the availability of health services in the United States.[26] The aim of this study is to determine (1) To what extent are the personnel and facilities for medical service on hand in the United States, and just how effective is the Nation's health machine in meeting the people's demands; (2) How best can any desirable improvements in the quantity of personnel and facilities for medical service be made, and how best can the quantitative effectiveness of the Nation's health machine be increased.

Meanwhile, President Truman has established a Commission on the Health Needs of the Nation, under the chairmanship of Dr. Paul B. Magnuson, formerly Medical Director of the Veterans Administration.[27] That commission has been conducting a series of panels on general practice, specialization, group practice, regionalization, promotion of health, prevention of disease, rehabilitation, training of physicians, training of nurses, training of medical associates, health of the aging, mental health, care of the chronically ill, research, industrial health, veterans and other Federal beneficiaries, rural health, military medicine, health

of mothers and children. If this list seems exhaustive, panels on other subjects will be scheduled and announced for July, August, and September.

The results of these and similar investigations are eagerly awaited by all concerned with health activities not only on this continent, but throughout the world. They will all throw light on some way of using modern skills of survey and analysis to improve our health practices. They will all give evidence of the need for pooling the experience and resources of physicians, dentists, nurses, sanitary engineers, health technicians, social workers, and a host of others in making this a healthier world for those now living and for those yet unborn. Social science research, teamed with the art and science of medicine, can help to conquer the external and environmental threats to human well-being and reduce the toll of illness and dependency. It deserves the strongest support we can muster.

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The Administration of Dental Public Health Services

ALLEN O. GRUEBBEL, D.D.S., M.P.H.
Secretary, Council on Dental Health, American Dental Association
Chicago, Illinois

PUBLIC health administration, in its beginning, was confined almost entirely to improvements in sanitation. Today, public health administration is concerned with a broader field of disease prevention, health education, and scientific investigations that require the skilled services of physicians, dentists, sanitarians, nurses, nutritionists, bacteriologists, chemists, health educators, psychiatrists, and other professional personnel.

Modern public health practice is founded on the application of knowledge gained through scientific investigation. Basic public health services no longer depend on the empirical judgment of persons who hope that a method may be successful simply because it seems to be the proper thing to do at the moment.

James Stevens Simmons, dean and professor of public health at the Harvard School of Public Health, pointed out recently that:

> Throughout the million or so years of human existence, man has worried about the diseases which affect him and has spent much time, effort and money trying to cure and prevent these afflictions. Until recently, he failed because he knew nothing about the etiology of these diseases and assumed that they were caused by such vague, imaginary things as evil spirits, malign influences or malodorous effluvia. He wasted a million years buying charms, paying tribute to witch doctors, placating his household gods, and taking worthless patent medicines. In brief, he put his money on the wrong horse.[1]

It has not been many years ago that man was putting his money on the same kind of horse in his attempts to prevent and cure dental disease. Fortunately, that day has passed. The practice of dentistry and the administration of dental public health programs now are based on a body of knowledge gained through scientific investigation.

Until recently, dental diseases were considered the most perplexing of all public health problems and the outlook for control held little optimism. The size of the problem was so large and the means for combating it were so inadequate that the inclusion of dental health activities in the public health program of health departments was not enthusiastically supported by many health officers.

The outlook for the future is far more optimistic. Today, a large portion of dental caries usually expected to occur, especially in children, can be prevented. There are many indications that dental health education is overcoming indifference to dental ill-health and is creating a greater appreciation for a clean and healthy mouth. A higher level of dental health can be realized in the years

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immediately ahead if the technics that have proved their worth are put to the fullest possible use.

The horizon of public health practice is expanding so that we can see new opportunities for service to the public and new methods for helping people achieve a healthier and happier life.

In a large sense, communicable diseases are under control. Time and energy now can be devoted to the prevention and control of chronic diseases and to other conditions that may not necessarily result in severe illness or early death. In days gone by, public health administrators gave almost no attention to dental diseases, cardiac and cardiovascular diseases, cancer, nephritis and diabetes. Progressive health departments are now taking steps to develop sound public health measures to prevent and control these conditions which today are mainly responsible for ill-health and abnormal body functions.

We do not know precisely to what extent dental diseases contribute to serious illness and death. We do know that dental diseases often are painful and, if not corrected early, result in disfiguration, loss of mouth function, interference with work and enjoyment of living.

Public health dentistry is a comparatively new branch of public health practice. At the outset, its achievements were not especially noteworthy, with two exceptions: (1) dental health education projects created an awareness of the importance of oral health to the individual and to the nation as a whole, setting the stage for inauguration of other important dental public health services, and (2) the establishment of dental units in health departments created a need for the training of dentists in public health administration, and thus public health dentistry was placed on a sound and scientific foundation.

Although the public health dentist is a specialist in a particular field, he is a member of a team of professional people who work together on related public health services: maternal and child hygiene, nutrition, water treatment, industrial hygiene, laboratory diagnostic services, control of cancer, of venereal disease and of tuberculosis, to name a few.

The public health dentist works closely with private dental practitioners and with dental societies. They, in turn, work and cooperate with him because of a mutual understanding that public health dentistry and private practice have their own fields in which to operate. There are not—or at least there should not be—any basic conflicts between the two, because one supplements the other and each provides services that are needed by and are important to the community.

Public Health Aspects of Dental Disease

Dental caries and periodontal diseases are chiefly responsible for the loss of teeth. Studies at the University of Minnesota and at the University of Michigan have shown that in persons of all ages, dental caries was responsible for 51 per cent of tooth extractions. Periodontal diseases accounted for 32 per cent and prosthetic corrections for 13 per cent. Extractions resulting from accidents and impactions amounted to only 4 per cent. Caries was found to be the chief cause of loss of teeth in persons less than 30 years of age. In older persons, teeth are lost usually because of periodontal diseases.[2, 3]

Contrary to general belief, dental caries is more prevalent today in the United

States than it was in previous years. I have no reason to doubt that this situation exists also in Canada. In a comparison of dental conditions of freshmen students at the University of Minnesota in 1949 with those who attended the University in previous years, it was found that teeth are now decaying to a greater degree than they were ten years ago and still to a greater degree than they were twenty years ago.[4] A study in New Jersey revealed that dental caries appears to be increasing in children.[5]

Owing largely to the extensive prevalence of dental caries, it has been common practice to give almost complete attention to this disease in planning community dental health programs. Although the prevention and control of dental caries is an extremely important part of a dental health program, consideration should be given also to methods for intercepting malocclusion, prevention and control of gingivitis, correction of oral clefts and speech rehabilitation, and early detection of oral cancer.

Thus far, dental caries is the only dental disease or abnormality for which extensive and accurate data have been collected as to its distribution and rate of occurrence in the population. The dramatic advancements in the discovery of methods for partially preventing dental caries were made because public health dentists and dental research workers developed methods for collecting and analyzing data on when, where and under what conditions dental caries occurs. By applying the principles of epidemiology and by developing a caries experience index, it was possible to measure the incidence and prevalence of dental caries, to determine the efficacy of preventive measures used in controlled studies, and to evaluate the effectiveness of dental health programs.

It is not necessary to elaborate here on the prevalence of dental caries. All public health workers know how widely distributed this disease is and how difficult it has been to check its ravages in terms of crippled mouths, pain, lost teeth, and masticatory malfunction. It is well known also that there are not enough dentists to fill all of the carious lesions that occur annually and that the only sound approach to a solution of the problem is to find effective preventive measures. Fortunately, such measures have been found and are now being put to use on a large scale. A brief description of these procedures is given in a later section of this paper.

Dental caries is by no means the only oral disease that has public health implications. If the time should come when dental caries is eliminated as a health problem—a realization that will take many years to accomplish—we still shall be confronted with the need for controlling malocclusion and other anomalies and deformities, traumatic injuries, periodontal diseases, and other oral pathoses.

In working toward these new goals for the future, public health dentists should be making plans for finding ways to measure the occurrence of these defects, for conducting or assisting in investigations that will lead to prevention and control measures, and for making practical application of such measures consistent with sound public health procedure.

Preliminary work has begun on devising a method for measuring the prevalence of malocclusion in large population groups.

There have been wide variations in the reports of the prevalence of gingivitis, owing, in all probability, to a lack of uniformity in the criteria used in examina-

tions. Recently, the P-M-A index has been devised to measure the prevalence of gingivitis. Since the work is still in the experimental stage, it is not possible to draw conclusions on the validity and practicability of this measuring device.

Prevention of Dental Caries

It is not possible in this presentation to give a comprehensive report of the scientific findings concerning the cause of dental caries. Nor is it possible to give a review of the scientific literature on which present-day caries-preventive measures are based. However, in view of the fact that today a large part of dental public health administration is devoted to the prevention of dental caries, a brief résumé will be given of the present status of four methods that have been demonstrated scientifically to be effective. Tooth decay cannot be prevented entirely at the present time, but its occurrence now can be markedly reduced through the use of these preventive procedures: water fluoridation, topical fluoride applications, toothbrushing and reduced sugar consumption.

Water Fluoridation

The expression "fluoridation of water supply" refers to the adjustment of the fluoride content upward to a desirable level in water that is deficient in the substance. Fluoridation of the public water supply has been demonstrated to be a practical and safe procedure for preventing from 40 to 60 per cent of dental caries if it is used continuously from birth.[6] Fluoridation offers the greatest hope for preventing caries because of its easy application for large numbers of people and its relatively low cost.

For more than three decades, it has been known that the teeth of persons who, since birth, have consumed water containing an optimum amount of fluoride have an unusual resistance to tooth decay. Studies have demonstrated conclusively that there is approximately three times as much dental caries in children who use fluoride-free water as there is in children who are born and reared in communities whose water supplies contain a concentration of about one part per million of fluorine (1 ppm).

I am not in a position to state whether the dental, medical, and public health organizations in Canada have taken formal action with regard to fluoridation. In the United States, the consensus of health officials is that carefully controlled scientific tests show that all children living in a community with a public water supply now can be partially protected against dental caries by the fluoridation of that water supply. Children who drink water containing the optimum amount of fluorine from birth will receive the greatest benefit. The protection against caries (up to 60 per cent) continues throughout life. Children who are older when they begin drinking water that contains the desirable amount of fluoride will receive substantial protection against dental caries but not as much as the younger children.

Fluoridation does not affect the taste, odor or colour of water; nor does it cause any interference with the domestic or industrial use of water. Fluoridation is inexpensive. The cost varies in different areas from 5 to 15 cents a year per person.

Although the mechanism by which fluoride prevents dental caries has not been

definitely established, it is generally believed that the consumption of fluoride-bearing water during the period when teeth are developing produces a tooth structure that is more resistant to mouth acids. It is possible also that fluorine may inhibit the bacterial or enzymatic processes involved in the formation of mouth acids.

Too much fluoride in the drinking water causes a hypoplasia of the enamel, a condition known as dental fluorosis or mottled enamel. With the exception of this defective tooth formation in high fluoride areas, no scientist has found any harmful bodily effects as a result of the drinking of fluoride-bearing water. Millions of people for generations have used naturally-occurring fluoride water. In some communities the natural fluorine concentration in water is from two to five times higher than is recommended for fluoridation. The only ill effects found in even the highest fluoride areas is dental fluorosis.

Many scientific bodies and other organizations concerned with public health have accepted fluoridation as a desirable and safe procedure. The organizations include the American Dental Association, American Medical Association, American Public Health Association, National Research Council, U.S. Public Health Service, State and Territorial Dental Health Directors, American Association of Public Health Dentists, and the State and Territorial Health Officers Association.

Topical Fluoride Applications

Numerous studies have demonstrated that the topical application of sodium fluoride solution to the teeth of children also will reduce the incidence of dental caries sufficiently to justify its use in private dental practice and in public clinics.[7]

The term "topical application of sodium fluoride" refers to the use of a 2 per cent solution of sodium fluoride on the surfaces of teeth. In using the procedure, the dentist or hygienist cleans the teeth, dries them thoroughly, and then applies the solution, allowing it to dry on the teeth. Four separate applications are given in each complete series. It is recommended that a series of applications be given several times during childhood, the times to be selected according to the eruption pattern of teeth.

Topical fluoride applications will not halt tooth decay once it has started, but they help materially to prevent new decay in the teeth of children. Topical fluoride applications should be available to all children who have not consumed fluoride-bearing water since birth. However, fluoride applications to the teeth of children born and reared in fluoride areas do not provide sufficient additional benefit in caries prevention to justify their use.[8]

It is recommended that topical applications be applied to the teeth of those children who reside in fluoride areas but who have calcified their teeth on fluoride-deficient waters. For that reason, it is advisable to continue topical fluoride applications in communities in which the public water supply is being fluoridated until all children are provided fluoridated water from birth.

Toothbrushing

A recent study involving a relatively large number of individuals has shown that the removal of carbohydrate material from the teeth by proper toothbrushing

aids materially in preventing caries.[9] In order to obtain maximum benefit from toothbrushing, it is necessary to brush the teeth or at least rinse the mouth with water within a few minutes after the consumption of food or confections. Obviously, this procedure has some drawbacks for children as well as adults who do not have easy access to the oral hygiene procedure immediately after eating. Acids form rapidly after carbohydrates, especially sugars, are taken into the mouth. The maximum production of acid usually occurs within twenty minutes to a half hour. Within an hour and a half, conditions return to their original state and the attack of caries is over for the moment.

Toothbrushing not only helps to keep teeth clean, it aids also in the prevention and control of disorders of the gums.

Dentifrices containing substances especially designed to prevent dental caries have been widely advertised. The real value of these preparations will not be known until research studies now under way are completed.

Reduced Sugar Consumption

Although carbohydrates are important constituents of a well-balanced diet in order to provide the energy needed for muscular activity, the excessive and frequent use of sugar is harmful to teeth. Excellent results in caries reduction have been obtained by decreasing the consumption of syrups, jams, jellies, and sweet confections and beverages.

Schools can help children to safeguard their teeth, as well as to adopt healthful eating habits, by discontinuing the practice of selling or distributing candy and sweet beverages on school premises. School authorities long have recognized the importance of sanitation and similar measures in creating a healthful school environment, but the importance of preventing ill-health through the careful selection of meals and between-meal snacks, unfortunately, has not received the same attention.

Dental Inspections in Schools

For many years periodic dental inspections were made in schools and in many localities still constitute an important part of dental public health practice. School dental inspections are particularly noteworthy at the moment because all public health dentists no longer are in agreement on the desirability of continuing this service on a routine basis. Some dentists believe that school dental inspections obtain results that cannot be obtained in any other way. Other dentists believe that the same results can be obtained in other ways that are less time-consuming for the child, school teacher, and dentist alike.

I am in a good position to argue both sides of this question because I have been an outspoken advocate of dental inspections in schools and, lately, a reluctant doubting Thomas. Be that as it may, I am sure that any pronouncement made by me would have very little effect on settling the issue. The best I can do is to supply a list of possible benefits and a list of limitations and possible undesirable effects.

Possible benefits. School dental health inspections or surveys may:

1. Serve as a basis for school dental health instruction,
2. Provide favourable mental conditioning of the child toward the dentist and dental care,

3. Motivate the child to seek adequate professional care,

4. Serve as a fact-finding experience for students, teachers, dentists and others concerned with school dental health,

5. Provide base-line and cumulative data for evaluation of the program,

6. Provide information as to the status of dental needs so the advisability of supporting a sound dental health program may be recognized.

Limitations and possible undesirable effects. School dental health inspections may have the following effects:

1. Even though the statement may be made that the school dental inspection is not intended to replace accurate and complete examination, parents and children frequently accept the inspection on this basis and depend on it rather than on a complete dental examination by the family dentist.

2. Unless it is possible to institute a definite follow-up program to assure that needed dental corrections are being made or to find out the reasons for lack of care, an annual dental inspection program primarily for purposes of motivation is of questionable value.

3. It is desirable for parents to be present during a dental examination, particularly of children in the younger age groups. This procedure is not always feasible in school inspections.

4. It is desirable for a child to learn the habit early in life of visiting his family dentist regularly for examination and care. Some school inspections may tend to discourage rather than to promote the development of this habit of personal initiative.[10]

Dental Referral Card System

The dental referral card system is widely used and produces good results in referring children to the dentist for examination and treatment. The dental card is distributed to each child by the classroom teacher. The pupil takes the card to the family dentist or to the clinic if he is classified as a needy child. The dentist signs the card when he has completed all necessary dental treatment. The card is returned to the teacher and becomes a part of the school record.

Basic Dental Public Health Services

The objectives of dental public health are to promote oral health by placing emphasis on the prevention of diseases and oral maldevelopment; to promote the development of methods for the early detection and the control of such conditions when they are not prevented; to promote the development of the knowledge and attitudes that will motivate the dental profession to practise, the local health officers and other officials to sponsor, and the public to accept these preventive and control techniques.

In order to achieve these objectives a number of basic dental public health services are suggested. All of the following services fall within the fundamental philosophy of public health and form a practical approach to the inauguration and maintenance of effective dental health programs:

1. Motivating people to seek adequate oral health care by providing to individuals and groups consultative and educational service in every area of oral health.

2. Assisting in the continued education of the dental profession in oral care through cooperation in refresher courses, such as in dental practice for children, in radiologic diagnosis, in orthodontic treatment, in treatment of periodontal diseases, in the rehabilitation of patients with oral clefts, in the use of auxiliary personnel in preventive measures or in other specialized knowledges.

3. Promoting and conducting studies to determine the extent of the oral health problem of a state or a community, conducting research on methods of meeting and reducing the

oral health needs and motivating the public and the dental profession to accept the results of such research.

4. Promoting the availability and utilization of laboratory diagnostic services, such as lactobacillus counts, Sneider tests, determination of fluoride concentrations in water supplies, biopsy and bacterial examinations, in order to assist in early detection or prevention of oral disease or to evaluate the progress of treatment.

5. Engaging in administrative research to develop more effective methods for achieving the objectives of dental public health.

6. Developing and testing new indexes for oral health appraisals, determining base lines for evaluation of dental public health programs.

7. Developing standards for the efficient administration of the office of the dental health director in such activities as the preparation of budgets, office routines, personnel management; program planning, coordination of programs, participation in department staff meetings; preparation of reports, and development of scientific and functional education materials.[11]

Dental Treatment

The provision of dental or medical treatment is not a basic service in public health practice. Primarily, dental and medical care other than some preventive services do not fall within the scope of public health practice, but there are circumstances that make it difficult to establish hard-and-fast rules. This problem was discussed with a great deal of wholesome candor by Dr. William P. Shepard in his presidential address to the American Public Health Association at the 79th Annual Meeting in San Francisco on November 1, 1951. Dr. Shepard stated that: "The dividing point, if we must have one, between public health and the private practice of medicine is that point at which a health problem in a given community is of sufficient interest to a sufficient number of citizens so that some type of community organization is required to solve it. Obviously, no single individual or physician can provide a city with a pure water supply, nor can he provide the universal pasteurization of milk, nor of proper waste disposal. All the doctors together cannot bring about smallpox and diphtheria immunization of 85 per cent of the general population, though the doctors can be of great help. It requires community organization, best led by the health official. In most instances, the practicing physicians of the community are important as the first to recognize these problems and are at the forefront of the community organization designed to seek a solution. It is the rare shortsighted physician who opposes these movements."

Dr. Shepard also pointed out wisely that "It would seem therefore that public health should be the social arm of medicine, keeping its finger on the pulse of the body politic, while the practicing physician keeps his finger on the pulse of the individual patient. There are often great differences between the two."[12]

Dr. E. G. McGavran, dean of the school of public health, University of North Carolina, expressed a similar viewpoint on the basic philosophy of public health: "Our job is to diagnose a community's health needs and then to treat them—a field in which the practitioner is not qualified. We will not work on individuals, except for the purpose of community health, when the community demands that we, as public servants, undertake medical care of such individuals. We shall provide medical care under protest that it is not our function—not public health—and as soon as it can be assumed by those whose responsibility is individual health, we wish to be relieved of it."[13]

Administration of Dental Services

Successful dental health programs do not occur accidentally. Effective and sound dental public health services for the community can be developed only by careful planning and by making the best possible use of existing resources.

No single type of dental health program is suitable for every community. Conditions vary so widely in different areas that it would not be possible or desirable to establish a standard pattern for all communities. However, dental disease prevention should be the chief goal because a reduction in the incidence of the disease will not only reduce the size of the dental health problem but also will result in the saving of money for the taxpayer.

The primary responsibility for the administration of the dental public health services of a health department rests with the dental officer and his staff. In order to perform the duties of administration properly, the dental director should have direct access to the chief health officer of the health department on all matters of policy, he should have salary parity with other program directors, he should take part in major planning activities through participation in staff meetings, and he should keep in close touch with the dental profession by consulting with officials of dental societies at regular intervals.

The professional growth of the dental staff requires that staff education be organized on a sound educational basis which includes not only in-service training but also opportunities for formal graduate training in a school of public health as circumstances require.

All of these considerations will help to establish *esprit de corps* among dental staff members that, in turn, will encourage pride in the service and will greatly influence the quality of work performed and, in the final analysis, the achievement of the desired goals.

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Working with Human Nature

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SOME public health measures consist in the enforcement of sanitary laws and regulations. Nevertheless it is only exceptionally that their observance is imposed by force; in most instances, obedience is the result of persuasion, because the requirements were adopted for the general good. Otherwise, laws and regulations would not be obeyed and might as well be crossed off the statutes.

But in the realm of individual health the aim is the creation of personal health habits, and these cannot be imposed by force; they can only result from education. Therefore, when we are dealing with ways of life (religion, healthful living, manners, etc.), education is not a means of improving the mind for cultural purposes, it does not consist of mere learning, but it must lead to action. Consequently the health educator must utilize the various forces that can modify human behaviour.

Instruction imparts knowledge that justifies a way of life; motivation shows the advantages of adopting such a way of life. It does not create the advantages; it makes one see them, it renders one conscious of them, with a view to creating a will to initiate action. It is an application of pedagogical psychology.

An educator, before getting action, must have his idea accepted. Every new idea meets with various forms of resistance. These may be:

(a) Indifference, to overcome which requires the creation of a receptive mind, the stimulation of interest.

(b) Incomprehension, probably because of the lack of explanation.

(c) Hostility (often the result of vested interest), which must be changed gradually into friendship. First it may be wise to agree with the opponent, then to create doubt, and finally to answer the opponent's objections.

(d) Prejudice, a ready-made idea, already accepted as true in the neighbourhood without any individual reasoning.

(e) Routine, a habit that has become automatic and, because it requires no effort, opposes any change by force of inertia.

These forms of resistance which new ideas meet with are components of public opinion. It is all the more solid because it is based on the most sacred and deeply rooted human elements. Some of these elements are:

(a) Race, which, by its own culture, leads public opinion in a particular direction.

(b) Tradition, which transmits ideas, feelings, and customs of the past, and

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thus shapes the national soul. Tradition, as a factor of stability, can be a useful brake which makes it impossible for important changes to come about too rapidly. Progress should be by evolution, never by revolution.

(c) Time, a great builder, a great destroyer, a great healer. Once the ground has been prepared, time allows the idea to make its own way and so contributes to form public opinion.

(d) Institutions (such as religion, politics, legislation), which, because they arise from the needs of the people, are in conformity with their feelings and reflect public opinion.

If a new idea has been handled skilfully and if it has overcome or avoided the various forms of resistance, we have brought about "conviction". But there is the necessity to produce "action". For the will to decide upon action, "interest" must be added to conviction. Our conduct is not necessarily in line with our knowledge, or even with our convictions (for example, our habit of smoking).

Interest, in a broad sense, may be the memory of a satisfying experience, or may lie in the contemplated satisfaction of a fundamental human want or in that of a particular want of a group or an individual.

Leaving aside these particular wants, which are as numerous as groups or individuals themselves, one must keep in mind the general wants, whether they be positive desires or negative fears, that induce men to action, that direct their behaviour. What are these fundamental wants?

(a) The child wants to please his mother, his parents; he wants to grow, he likes to imitate.

(b) The adolescent is interested in sports, in his appearance; he wants to become popular; he may even be fully devoted to preparation for his career.

(c) The adult normally is devoted to his home and family (or possibly to religion, or to some form of service to his fellow-creatures); he will do anything he can for his children, for their growth, their welfare and their education. If he has met with success in his career, he will give his family luxury and may even give part of his fortune to philanthropic organizations.

(d) The aged are seeking distractions which they find in arts, literature, various hobbies; and, probably for the first time in their life, become interested in their health, which they feel they are now losing.

One can readily see the numerous motives, arising from the above wants, that the health educator can use to bring about desired action. In order to succeed more surely, he should, in doing so, apply the art of "suggestion".

Education and training are, in a sense, forms of suggestion. Let us limit ourselves, however, to a few tricks of the trade that aim to produce action by recognizing certain weaknesses or traits of human nature. These tricks make up the "know how", the technique, that belongs to those who enjoy the natural gifts of the teacher and that others acquire more or less painfully on the long road to experience.

(a) *Sympathy.* The health educator must feel at the same time as he thinks and he must show his feelings. As feelings are contagious, his audience will accept the new idea more readily if they have in the first place accepted the person of the educator. Their emotional impression will lead them to action, since a feeling moves more rapidly and more strongly than an idea.

(b) *Prestige.* Natural prestige is made up of certain attributes of personality (charm, assurance, poise, modesty, etc.). Acquired prestige, or reputation, follows competence and past successes. His or her reputation will make the task of the educator easier because, by impressing the audience, he or she renders them more receptive. It is also a good tactical procedure to use the prestige of the official authority that one represents. (A public health nurse who does not wear her uniform when she addresses a group is working without an efficient help, and in so doing decreases her prestige.)

(c) *Affirmation.* Affirmation, pure and simple, without any reasoning or proof, often convinces simple people. If incomplete or misunderstood explanations are given, doubt is introduced into their minds. When one justifies himself to excess, he gives rise to mistrust, while a categorical affirmation often cuts short all objections.

(d) *Repetition.* What is said but once is soon lost; repetition acquires the force of demonstration. People do not like to think; they prefer ready-made ideas. Repetition forces the ideas into the minds of the people, exempting them from thinking, yet satisfying their curiosity.

(e) *Symbols and Images.* Symbols are supports for an emotional charge. An image concentrates and intensifies the emotion and the power that the words bear in themselves. Expressive words have more force, because, in addition to their significance, they have an emotional charge that gives them a magic power. This explains the popularity of slogans, mottos and fancy formulas. It is because of the images that they create in the minds of the people, that promises move the crowds so much. One retains much more easily the memory of images than the memory of words.

(f) *Contagion.* What has been said to some will be repeated to others; it will be known by many more; the idea will make its way because a stream of opinion has been created. On the other hand, as feelings are contagious (for example, panic), an action originated in a small group may be repeated by a large number of people. The educator has taught and impressed a nucleus of converts, and from them contagion has acted on the others.

In matters of personal health, when the application of the above principles has brought about conviction plus the desired action, the satisfaction derived from the experience, and its pursuit, will cause a repetition of action to take place: that constitutes a habit.

There are in life sudden conversions, even in the field of health (for example, puberty and cleanliness, maternity and devotion to children); these miracles performed by nature are related to the strongest instincts of human beings. The educational process may be slower, but its results are more permanent; habits that become rooted slowly in a hard soil are all the more stable.

We have seen the various factors that constitute the many trump cards in the hands of the health educator, the many motives to exploit so that instruction may lead to action, the many elements that will add motivation to health education. These cards are not just to be shuffled; they must be selected cleverly. Unfortunately, there is no simple formula to be used as a guide. It will be necessary to adapt their choice to each situation that an educator will face. That is what makes our job so interesting.

Oral Use of Penicillin G Ammonium

SOME FACTORS AFFECTING THE SELECTION OF AN ADEQUATE DOSAGE SCHEDULE

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THE ammonium salt of penicillin has been almost overlooked as an agent of treatment although it is as free from toxic effects as other forms of penicillin which are in common use[1], and although it is satisfactory on the grounds of physical characteristics and stability. It is, moreover, the most economical pure form in which penicillin is produced at the Connaught Medical Research Laboratories. The present investigation was carried out in order to obtain information regarding the suitability of ammonium penicillin as an oral therapeutic agent.

METHOD

Doses of 500,000 or 1,000,000 International Units (0.33 or 0.67 gm.) of penicillin were administered orally to normal adults, in the form of 500,000 unit tablets or as a solution in cold tap water. All doses were administered between 8 and 9 a.m., either 45 minutes before breakfast or about 1 hour after breakfast. Blood samples were drawn at the times specified and the penicillin content of each serum was determined by a cup-plate method of assay with *Sarcina lutea* as the test organism. The reliability of this assay declines rapidly as concentrations fall below 0.05 units of penicillin per ml. of serum. For the purpose of the present investigation, zero values were arbitrarily substituted for all assay values of less than 0.05 units.

In the course of the study 42 volunteers, 12 female and 30 male, received penicillin. The different treatment schedules employed are described below.

(1) Eight subjects (Nos. 1-8) received 1,000,000 units of Penicillin G Ammonium *before* breakfast on one day and *after* breakfast on another day.

(2) Eight subjects (Nos. 9-16) received Penicillin G Ammonium on 4 different days. The doses given on the 4 occasions were 1,000,000 units before breakfast, 500,000 units before breakfast, 1,000,000 units after breakfast, and 500,000 units after breakfast. In this group the order of dosage was determined according to a latin square design so that each subject received each dose and each dose was administered to the same number of subjects on each test day.

(3) Nine subjects (Nos. 17-25) received one dose only—1,000,000 units of Penicillin G Ammonium before breakfast.

(4) Seventeen subjects (Nos. 26-42) received 1,000,000 units of *Penicillin G Ammonium* before breakfast on one day and 1,000,000 units of *Penicillin G Potassium* before breakfast on another.

Results

In Table I are shown the results from all 42 of the volunteers when 1,000,000 units of penicillin was ingested 45 minutes before the morning meal. Twenty-five received only ammonium penicillin and 17 received, on different days, ammonium and potassium penicillin.

As will be seen from Table I, a substantial serum penicillin concentration was found 15 minutes after ingestion of 1,000,000 units of ammonium penicillin.

TABLE I

SERUM PENICILLIN CONCENTRATIONS IN NORMAL ADULT SUBJECTS AFTER THE ORAL ADMINISTRATION OF ONE MILLION INTERNATIONAL UNITS (0.67 GM.) OF AMMONIUM OR POTASSIUM PENICILLIN

Each dose of penicillin was given about 45 minutes before breakfast.

				Penicillin in Units per Ml. of Serum (Blood Samples Drawn at Times Indicated)						
No.	*Subject*	*Sex*	*Wt.*	*15 Min.*	*30 Min.*	*45 Min.*	*1 Hr.*	*2 Hr.*	*4 Hr.*	*6 Hr.*
1	H. A.	M	178	0.87	3.9	4.2	3.4	—	0.18	—
2	J. H.	M	195	1.8	4.2	4.7	5.2	—	0.45	—
3	H. I.	M	148	0.8	1.4	3.2	5.3	—	0.30	—
4	S. K.	M	145	2.9	3.1	2.6	1.6	—	0.16	—
5	W. O.	M	135	2.6	3.8	3.6	3.6	—	0.60	—
6	L. O.	M	130	1.8	2.4	2.4	2.2	—	0.15	—
7	A. S.	M	122	1.7	3.2	3.1	2.9	—	0.11	—
8	W. S.	M	135	2.6	4.5	4.2	4.4	—	0.25	—
9†	G. E.	M	140	—	—	3.0	—	1.4	0.23	0.12
10†	B. H.	M	138	—	—	1.8	—	0.8	0.40	0.09
11†	G. H.	M	175	—	—	1.3	—	0.5	0.48	0.12
12†	C. H.	M	160	—	—	4.2	—	1.5	0.85	0.46
13†	E. M.	M	175	—	—	1.5	—	0.8	0.46	0.24
14†	G. P.	M	150	—	—	5.5	—	1.5	0.53	0.22
15†	G T.	M	155	—	—	1.9	—	1.2	0.74	0.18
16†	R. V.	M	137	—	—	0.22	—	0.0	0.00	0.00
17	C. F.	F	152	—	—	1.20	—	—	0.06	—
18	E. H.	F	123	—	—	3.1	—	—	0.88	—
19	W. B.	M	160	—	—	2.2	—	—	0.33	—
20	F. H.	M	185	—	—	3.2	—	—	0.41	—
21	K. I.	M	148	—	—	5.0	—	—	0.32	—
22	B. M.	M	130	—	—	2.2	—	—	0.48	—
23	H. P.	M	176	—	—	4.2	—	—	1.00	—
24	P. R.	M	166	—	—	3.5	—	—	0.25	—
25	N. T.	M	158	—	—	6.1	—	—	0.29	—
26	M. B.	F	130	—	—	2.2(2.3)*	—	—	0.15(0.15)*	—
27	T. D.	F	115	—	—	2.6 (2.5)	—	—	0.36(0.59)	—
28	L. F.	F	135	—	—	3.6 (3.9)	—	—	0.20(0.15)	—
29	B. G.	F	113	—	—	1.7 (2.8)	—	—	0.08(0.07)	—
30	E. L.	F	131	—	—	2.0 (4.6)	—	—	0.20(0.38)	—
31	N. M.	F	140	—	—	2.8 (4.0)	—	—	0.94(0.39)	—
32	M. M.	F	130	—	—	3.8 (1.4)	—	—	0.60(0.09)	—
33	J. P.	F	105	—	—	4.3 (3.4)	—	—	0.55(0.42)	—
34	A. S.	F	152	—	—	3.6 (1.3)	—	—	0.44(0.08)	—
35	L. T.	F	175	—	—	1.8 (2.0)	—	—	0.88(0.38)	—
36	R. J.	M	130	—	—	2.3 (4.5)	—	—	0.08(0.18)	—
37	K. G.	M	152	—	—	2.1 (1.9)	—	—	0.09(0.08)	—
38	W. L.	M	186	—	—	7.8 (7.8)	—	—	0.37(0.19)	—
39	A. L.	M	185	—	—	3.1 (4.1)	—	—	0.37(0.40)	—
40	F. M.	M	162	—	—	4.4 (3.5)	—	—	0.59(0.15)	—
41	G. M.	M	160	—	—	4.2 (2.6)	—	—	0.64(0.28)	—
42	G. S.	M	142	—	—	1.4 (0.97)	—	—	0.06(0.05)	—
	Average Values			1.88	3.31	3.14(3.15)*	3.58	0.96	0.39(0.23)*	0.18

*Serum levels in brackets obtained using potassium penicillin.

†Penicillin administered in 4 oz. of cold tap water. All other penicillin administered in form of rapidly dissolving tablets, each tablet containing approximately 500,000 units (0.33 gm.) of penicillin.

It rose rapidly, reaching a peak at about the end of the first hour, then declined rapidly during the second hour and less rapidly between the second and sixth hours after administration. In most instances therapeutic serum penicillin concentrations were found for at least six hours after ingestion of a dose.

Serum concentrations were compared 45 minutes and 4 hours after the administration of ammonium or potassium penicillin. Essentially the same effect was produced by the two agents.

A detectable serum penicillin concentration was not maintained for 2 hours in one of the subjects (No. 16) in this series. On three occasions when this subject was given ammonium penicillin, 500,000 units before breakfast, 1,000,000 units after breakfast, and 500,000 units after breakfast, his serum was found to contain an appreciable quantity of penicillin in every case at the time of the 45-minute, 2-hour and 4-hour bleedings. The reason for his anomalous response in the one instance is not known.

In Table II are presented the results obtained when 16 subjects (Nos. 1-16) ingested 1,000,000 units of ammonium penicillin about 1 hour after breakfast. The serum concentrations followed approximately the same pattern but were

TABLE II

SERUM PENICILLIN CONCENTRATION IN NORMAL ADULT SUBJECTS AFTER THE ORAL ADMINISTRATION OF ONE MILLION INTERNATIONAL UNITS (0.67 gm.) OF PENICILLIN G AMMONIUM

In each case the penicillin was taken about 1 hour after breakfast.

		Penicillin in Units per Ml. of Serum						
No.	*Subject*	*15 Min.*	*30 Min.*	*45 Min.*	*1 Hr.*	*2 Hr.*	*4 Hr.*	*6 Hr.*
1.	H. A.	1.40	2.1	1.9	1.3	—	0.07	—
2.	J. H.	0.20	0.5	0.5	0.6	—	0.10	—
3.	H. I.	2.50	2.2	1.8	1.4	—	0.14	—
4.	S. K.	0.00	0.1	0.2	0.3	—	0.00	—
5.	W. O.	0.99	2.6	3.3	2.8	—	0.21	—
6.	L. O.	0.18	3.6	1.4	1.1	—	0.00	—
7.	A. S.	0.39	1.0	0.6	0.6	—	0.06	—
8.	W. S.	0.38	1.2	1.6	1.4	—	0.21	—
9.	G. E.	—	—	0.53	—	0.19	0.05	0.05
10.	B. H.	—	—	2.80	—	0.76	0.22	0.13
11.	G. H.	—	—	0.58	—	0.11	0.06	0.00
12.	C. H.	—	—	2.00	—	1.11	0.39	0.22
13.	E. M.	—	—	0.71	—	0.26	0.14	0.09
14.	G. P.	—	—	0.40	—	0.06	0.00	0.00
15.	G. T.	—	—	3.3	—	2.50	0.85	0.29
16.	R. V.	—	—	0.99	—	0.44	0.25	0.00
Average Values		0.77	1.60	1.40	1.20	0.68	0.17	0.10

generally lower than those obtained when the dose was given before the morning meal. Penicillin was present in the sera of all 16 subjects 45 minutes after the doses had been given. Penicillin did not appear in the serum of one (No. 4) until after the 15-minute blood sample had been taken and in three (Nos. 4, 6 and 14) it could not be detected in the 4-hour sample.

Eight subjects (Nos. 9-16) ingested 500,000 units of ammonium penicillin before breakfast on one day and after breakfast on another. The results obtained are shown in Table III.

By comparing the results shown in Part 1 of Table III with those presented in Table II it can be seen that 500,000 units administered before breakfast and

1,000,000 units administered after breakfast produce approximately the same effects.

TABLE III

SERUM PENICILLIN CONCENTRATIONS IN NORMAL ADULT SUBJECTS AFTER ORAL ADMINISTRATION OF 500,000 UNITS OF AMMONIUM PENICILLIN

Part 1—Penicillin Administered 45 minutes before Breakfast

		Penicillin in Units per Ml. of Serum			
No.	*Subject*	*45 Min.*	*2 Hr.*	*4 Hr.*	*6 Hr.*
9.	G. E.	0.47	0.11	0.00	0.00
10.	B. H.	1.2	0.55	0.72	0.00
11.	G. H.	0.52	0.26	0.05	0.00
12.	C. H.	2.3	0.53	0.14	0.06
13.	E. M.	0.80	0.35	0.39	0.15
14.	G. P.	1.9	0.62	0.24	0.14
15.	G. T.	2.5	1.6	0.43	0.14
16.	R. V.	1.2	0.42	0.06	0.00
	Average Values	1.36	0.56	0.25	0.06

Part 2—Penicillin Administered 1 Hour after Breakfast

9.	G. E.	0.34	0.10	0.00	0.00
10.	B. H.	1.8	0.67	0.13	0.00
11.	G. H.	0.31	0.08	0.00	0.00
12.	C. H.	2.3	0.50	0.19	0.07
13.	E. M.	0.00	0.00	0.00	0.00
14.	G. P.	0.00	0.00	0.00	0.00
15.	G. T.	0.74	0.41	0.21	0.08
16.	R. V.	0.60	0.24	0.08	0.00
	Average Values	0.76	0.25	0.08	0.02

When 500,000-unit doses were given after breakfast, the serum levels obtained were erratic. As can be seen from Part 2 of Table III, two subjects out of eight failed to show detectable serum concentrations of penicillin at any of the bleeding times chosen and in two others the levels were very low.

The results obtained from the eight subjects (Nos. 9-16) who received all 4 of the treatments with ammonium penicillin are presented in the graph. Average serum levels of penicillin are plotted against time after administration.

Palatability

Ammonium penicillin, in common with other penicillin preparations, has a bitter flavour. In the present investigation the flavour was sufficiently masked when the material was given in tablet form or dissolved in cold water. No objections, on grounds of palatability, were raised by any of the participants.

Sensitivity

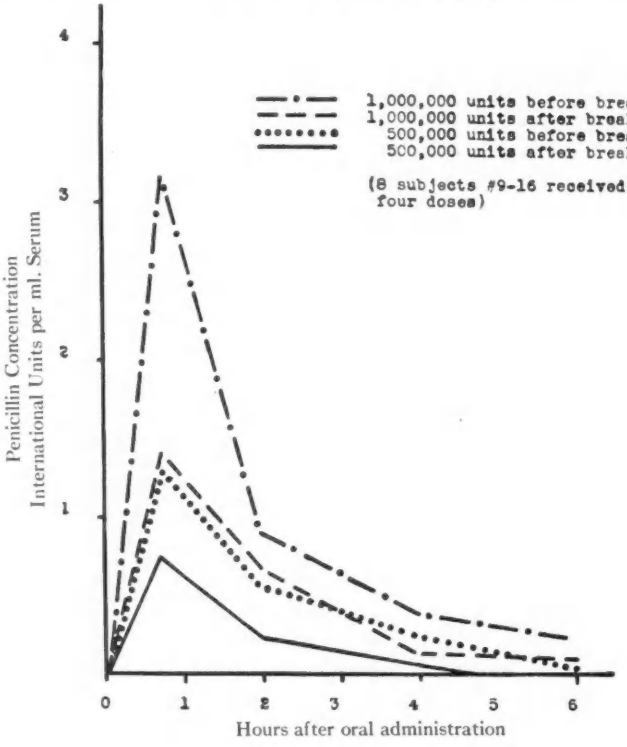
One subject (No. 19) developed an urticarial rash ten days after he had swallowed 1,000,000 units of ammonium penicillin. The rash appeared on the upper extremities and trunk and over a 24-hour period extended to the lower trunk and lower extremities. Itching was intense. Antihistamines and topical applications were employed in therapy. The reaction subsided over a three-day period. This subject had worked in a penicillin plant for six years but had never received penicillin therapy.

A delayed reaction of the type seen is not uncommon after the administration of intramuscular penicillin. In one series of 10,000 luetics who were given intramuscular penicillin, 2.5% developed a delayed urticarial reaction[2].

There is no good evidence to suggest that adequate oral penicillin therapy differs from adequate intramuscular penicillin therapy as regards the incidence, type or severity of the generalized reactions produced.

No noteworthy gastro-intestinal upsets were encountered in this study. One subject reported diarrhoea of a mild character for a few hours after ingesting 1,000,000 units of ammonium penicillin.

SERUM LEVELS OF PENICILLIN AFTER PENICILLIN G AMMONIUM BY ORAL ADMINISTRATION



Discussion

There is convincing evidence in the literature to support the assertion that suitable penicillin preparations when administered orally in adequate dosage control infections caused by penicillin-sensitive micro-organisms.[3–12] A number of penicillin compounds, including the sodium, potassium, calcium, aluminium, procaine, and ethyl-tyrosine derivatives, have been shown to be suitable for this type of therapy[7, 8, 9, 13, 14, 15]. The findings reported in the present paper indicate that ammonium penicillin may be included in this group.

A number of authors have reported a decrease in the amount of penicillin which passes from the gastro-intestinal tract into the serum when the dose is administered after a meal rather than before[4, 9, 11]. The present work confirms

this finding. One million units of ammonium penicillin ingested 45 minutes *before* breakfast resulted in satisfactory serum concentrations of the antibiotic in almost every case. One million units *after* breakfast resulted in concentrations which were lower and not as consistently prolonged. Five hundred thousand units before breakfast provided about the same results as 1,000,000 units after breakfast. Five hundred thousand units after breakfast often produced no detectable effect. A further study is planned to collect information with regard to the effect of the noon and evening meals on absorption of penicillin from the gastro-intestinal tract.

It is the general impression that the oral dose of penicillin for adults should be about five times as great as the intramuscular dose which would be employed [4,9,16]. The high cost of penicillin has, until recently, been an important factor in rendering oral treatment unpopular. At present, because of a decline in price, it is economically feasible to provide the required doses.

Oral therapy with penicillin has advantages over intramuscular therapy. It avoids the inconvenience and expense of intramuscular injections. It is more acceptable to the patient. It avoids the higher manufacturing costs of sterile materials for parenteral injection. Suitable agents can be stock-piled indefinitely in a dry state as a preparation for emergency requirements. Because of its advantages, the conditions under which its use may be advocated with confidence deserve careful study.

Conclusions

1. Reasonably high and consistent serum penicillin concentrations result in normal adults if 1,000,000 units (0.67 gm.) of ammonium penicillin is administered 45 minutes before breakfast or 1 hour after breakfast. The penicillin concentrations attain peak values within 1 hour and (in most cases) therapeutic levels are maintained for at least six hours.

2. Serum penicillin concentrations tend to attain higher peak values and to be more consistently prolonged when a given oral dose is administered before breakfast rather than after. This finding has been reported by previous workers.

3. After breakfast an oral dose of 500,000 units of penicillin cannot be relied upon to produce a detectable serum concentration.

4. When the ammonium and potassium salts of penicillin are administered at comparable dosage, the serum concentrations which result are essentially the same.

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A COMBINED SANITIZING DETERGENT

THE RESULTS of a research project supported by a Public Health Research Grant under the National Health Program are recorded in this issue. The study relates to the highly important problem of the effective sanitizing of dishes and eating utensils. The investigations have extended over several years and have been conducted by Mr. K. H. Geiger, M.A.Sc., under the direction of Dr. P. J. Moloney, of the School of Hygiene, University of Toronto.

In a word, their work demonstrates that chlorine may be rendered effective as a sterilizing agent in the presence of large amounts of organic matter, and that chlorine may be suitably compounded with soaps and certain detergents, to give a combined sanitizing-detergent agent.

Public health workers are fully aware of the problem presented in hand dish-washing, not only in public eating places but also in homes. Regulations are generally in force in Canada requiring the installation of three sinks in the kitchens of restaurants and other eating places. The first sink is employed solely for the purpose of cleaning, for it is recognized that unless the dishes or utensils are thoroughly cleaned, the sanitizing agent, whether chlorine or a quaternary compound, will not be effective. The second and third sinks are for rinsing and for treatment with sanitizing agents, the order of the operations depending on the sanitizing agent used.

The research study indicates that with a suitable chlorine-detergent preparation, two sinks may be used instead of three. In the washing, the dishes are cleaned and at the same time are exposed to the action of chlorine. It has been shown that dishes washed with such chlorine-detergent, in water containing large amounts of organic matter, were not only effectively cleaned but were satisfactory bacteriologically.

There is ample evidence that communicable diseases may be transmitted through the use of improperly washed eating utensils. The newer knowledge of virus infections indicates that viruses present in the intestinal tract may also be transmitted in this way. The importance of safeguarding against infection by the use of an effective chlorine detergent needs no emphasis. If the findings are established by extensive trials, a highly important advance in sanitation will have been made.

ORAL ADMINISTRATION OF PENICILLIN G AMMONIUM

THE ORAL ADMINISTRATION of penicillin and, in particular, the suitability of ammonium salt of penicillin, is discussed in a paper in this issue. The article is timely because of the rapid extension of the use of penicillin by the oral route.

The question may be asked, what is the reason for the growing use of the oral route? The answer lies in the present low prices of penicillin and the availability, in large quantity, of the various salts of penicillin in crystalline form. When penicillin was in limited supply and costly, oral administration was not practical. It was necessary to administer penicillin by injection, since approximately five times the amount was required when oral administration was employed.

Other essential information has been established by clinical studies. Penicillin is known to be absorbed readily from the intestinal tract when given in the form of sodium or potassium salts and that satisfactory blood levels of penicillin are obtained. It is known, too, that these levels are influenced by the time of administration in relation to meals. Lower levels follow administration after meals. It was thought necessary to add a buffer to prevent destruction of penicillin by gastric secretions. From the findings in this paper and other published data, the use of a buffer may be omitted. This finding makes possible the administration of 500,000 units of penicillin in a tablet which can be conveniently swallowed. It is of interest to learn that the ammonium salt of penicillin, which has not been in general use, gives results quite comparable to those obtained with sodium or potassium. In these studies ammonium penicillin was selected because it was the most economical form in which crystalline penicillin was available in the institution.

The distribution of tablets of 100,000 units, or, recently, of 200,000 units, and the emphasis placed on the advantages of the oral route, may lead members of the medical and dental professions, and hospitals, to use inadequate quantities. The administration of quantities of penicillin considerably in excess of 200,000 units is recommended by Keefer. The distribution of tablets of 500,000 units is therefore to be commended, as they would encourage the administration of adequate doses.

It has long been appreciated that the unit of penicillin which was chosen in 1941, and designated the Oxford Unit, is far too small. In the case of other antibiotics it is common practice to prescribe in "grams" rather than "units". Doses of from one to two million units of penicillin daily are quantities of from 0.6 to 1.2 grams, approximately. These amounts are comparable to those recommended in the case of other antibiotics.

The advantages of oral administration are appreciated by physicians and patients alike. Both in hospitals and in homes, economies may be effected when penicillin is administered orally. It would be most unfortunate if, as a result of inadequate doses of penicillin, oral administration should become discredited. There is a very real danger that this will occur unless information concerning the necessity of employing doses of one to two million units daily is made widely known. It can be appreciated that the distribution of tablets of 200,000 units or less tends to result in inadequate dosage. The objective is to provide penicillin in adequate quantity, and to achieve this the cost should not exceed that of parenteral administration.

NEWS

Saskatchewan

THE DEPARTMENT of Public Health has embarked on a continuing program of home safety education. This will be expanded later to include farm safety education, which will be conducted in cooperation with the provincial Department of Agriculture.

AT THE meeting of the Canadian Public Health Association, held in Winnipeg in June, Mr. G. W. Myers was elected 2nd vice-chairman of the Vital and Health Statistics Section. Mr. Myers is the executive director of the Saskatchewan Hospital Services Plan.

DR. D. G. MCKERRACHER, director of the Psychiatric Services Branch of the health department, has been awarded a bursary under the National Health Grants to take a year's postgraduate study in psychiatry at the Western Reserve University Hospital in Cleveland, Ohio. He will study the development of psychiatric services in general hospitals and of preventive psychiatric services. Dr. R. O. Davison, superintendent of the Saskatchewan Training School, Weyburn, is acting as director of psychiatric services during Dr. McKerracher's absence.

STANLEY C. BEST, B.A., M.D., M.P.H., resumed his duties as director of child health on July 1st after obtaining the degree of Master of Public Health, cum laude, from Harvard University. His year's postgraduate course at the Harvard School of Public Health was made possible by a bursary awarded under the National Health Grants. Dr. Best majored in maternal and child health and made a special study of maternal attitudes. He also holds a specialist certificate in paediatrics from the Royal College of Physicians and Surgeons of Canada.

EDWARD L. ABBOTT, B.A., B.Ed., for the past three years teacher-psychologist in the North Battleford School Superintendency, has been appointed assistant director of health education. Mr. Abbott has had 14 years' teaching experience in rural and high schools in Saskatchewan. During World War II, he served for four years as a radar technician with the Canadian Army. On leaving the service, he obtained the degrees of bachelor of arts and bachelor of education at the University of Saskatchewan. Following this, he took a year's course in mental hygiene sponsored by the University of Toronto and the Canadian Mental Health Association. Mr. Abbott succeeds Harold Lobb, B.A., M.Ed., who has accepted the position of executive director of the Saskatchewan division of the Canadian Mental Health Association.

MISS MARY GARDINER, B.A., B.Ed., has assumed the duties of health educator on the headquarters staff of the Division of Health Education. She holds a bachelor of arts degree from Queen's University and a bachelor of education degree from the University of Saskatchewan. Miss Gardiner taught in collegiates in the province before entering the newspaper field with the Prince Albert Herald in 1942. She held successively the posts of city and news editor, becoming managing editor in 1948.

ROBERT D. DONNELLY, B.Sc., M.A.Sc., public health engineer with the Division of Sanitation for the past 14 months, has left for Charlottetown, P.E.I., where he has accepted the position of director of sanitary engineering with the Department of Health and Welfare.

A SUMMER SESSION of the Canadian Hospital Council extension course in hospital organization and management was held at Regina College, Regina, from July 14th to August 8th. This extension course is an integrated program extending over two years and conducted on an extramural basis. At the end of each year's study, students must attend a four-week summer session at a specified university. This year, the sessions were held at Regina College and Queen's University. This project is a cooperative effort between the Canadian Hospital Council and the Department of Hospital Administration, School of Hygiene, University of Toronto. At Regina College, the enrolment was 18, with students coming from British Columbia and the three prairie provinces. Among the instructors were a number of senior members of the Saskatchewan Department of Public Health.

Manitoba

H. BELL, M.D., D.P.H., has resigned his position as medical director of the Brandon Health Unit, Manitoba Department of Health and Public Welfare. He has joined the staff of the Greater Vancouver Metropolitan Health Area, Vancouver, and will be posted to the North Shore Health Unit.

UNDER A UNITED NATIONS travelling study grant, Mr. K. Bjerkomp, of the Ministry of Health, Norway, recently visited the Manitoba Department of Health and Public Welfare to study administrative procedures.

SIX PUBLIC health nurses attended the University of Minnesota for the summer course of post-graduate study in public health nursing education. They were: Miss E. Brown, Transcona Nursing Station; Miss C. Brunskill, Red River Health Unit; Miss E. Elder, Virden Health Unit; Miss M. Henderson, Dauphin Health Unit; Miss R. Jory, Swan Valley Health Unit; and Miss J. Prested, Selkirk Health Unit.

MISS JANET KENNEDY, Northern Health Unit, and Miss June McLelland, Swan Valley Health Unit, are attending the University of Minnesota for one year of post-graduate study in public health nursing education and supervision.

MISS W. M. BARRATT, registrar consultant for licensed practical nurses, this summer attended a three-week workshop for administrators and instructresses of schools for practical nurses. The first two weeks of the workshop were held at Wayne University, Detroit, and the third week at the Kellogg Continuing Centre, East Lansing, Michigan. The workshop was sponsored by the Kellogg Foundation.

MISS J. DEBRINCAT, public health nursing consultant, has been loaned to the Attorney-General's Department to assume the duties of civil defence nursing coordinator for Manitoba.

MR. O. G. ESKEVAN, of the Division of Social Work, Ministry of Health, Norway, spent several days in Manitoba in June to study the relationship between health and welfare. He visited the Red River Health Unit and conferred with officials of the Department of Health and Public Welfare. Mr. Eskevan was travelling under a United Nations travelling study grant. During his visit he attended the meeting of the Canadian Public Health Association in Winnipeg.

BECAUSE the number of cases of poliomyelitis was greater than normal, the Minister of Health and Public Welfare, the Hon. Ivan Schultz, set up a Technical Advisory Committee on Poliomyelitis, under the chairmanship of Dr. J. D. Adamson, in July. This committee was formed to advise municipal medical officers of health and other medical personnel about procedures to be followed in the affected areas. Representation on the committee includes the Manitoba Department of Health and Public Welfare, the City of Winnipeg Health Department, the Winnipeg hospitals, the Manitoba Medical Association, and the Medical Faculty of the University of Manitoba.

THE OFFICIAL openings of the Morden District and the Virden District Hospitals took place in late June and early July. These hospitals were built under combined Provincial and Federal grants. Morden Hospital contains 57 beds and Virden Hospital 34.

C. E. MCEWAN, C.S.I.(C.), sanitary inspector with the Portage la Prairie Health Unit, transferred to the Virden Health Unit on September 1.

MR. K. G. MCQUARRIE, consultant sanitarian, has been appointed to the newly formed Field Advisory Staff for Local Health Units, to provide supervisory and consultant services. The field staff will coordinate the work and policies and enable an accurate appraisal to be carried out between units. This project was made possible by a Federal health grant.

Ontario

THE FOLLOWING new pamphlets have been prepared and are being distributed by the Ontario Department of Health: "Enjoy Your Vacation", "Rats", and "The Lunch Box from Home".

A MINIATURE theatre featured the Department of Health's display at this year's Canadian National Exhibition in Toronto. Two pictures were presented. One, "House of Mercy", dealt in story form with the operation of a modern hospital, and the other, "Unsuspected", offered a constructive approach to the problem of tuberculosis. Another section of the exhibit featured the fight being waged against tuberculosis and gave the public the opportunity to discuss with technicians the operation of microscopes and to witness, under microscopic glass, the growth of tubercle bacilli on culture media. In another section, colored cartoons, flashing on a screen, depicted the work of other divisions of the Department.